AMENDMENTS CLAIMS

What is Claimed is

1. (Presently Amended) A method of detecting an abnormal situation associated with a process plant, comprising:

receiving measured data pertaining to a process parameter sensed by at least one sensor device associated with the process plant;

collecting a first set of data points for the process parameter from the measured data;

using a processor for determining a frequency component of the process parameter based on the collected first set of data points for the process parameter;

using a processor for determining a dominant system time constant from the frequency component and setting a block length for calculating a statistical measure from the measured data based on the dominant system time constant;

using a processor determining one or more statistical measures associated with the process parameter using the measured data received during a block of time corresponding to the block length; and

using a processor for detecting an abnormal situation in the process plant based on the one or more statistical measures associated with the process parameter ~~to detect an abnormal situation within the process plant~~.

2-4 Canceled

5. (Previously Presented) The method of claim 1, wherein determining the frequency component includes performing a Fourier Transform on the collected number of first data points.

6. (Previously Presented) The method of claim 1, wherein setting the block length includes selecting the block length as a multiple of the dominant system time constant.

7. (Previously Presented) The method of claim 1, wherein determining the dominant system time constant includes determining a corner frequency from the frequency component and determining the dominant system time constant as a factor of the corner frequency.

8. (Original) The method of claim 7, wherein determining the corner frequency includes determining a first frequency component with a peak magnitude and determining a further frequency component at which the magnitude of the further frequency component drops to a predetermined factor below the peak magnitude of the first frequency component.

9. (Original) The method of claim 1, wherein determining the one or more statistical measures includes fitting the measured data to a sine wave.

10. (Original) The method of claim 9, wherein fitting the measured data to a sine wave includes determining first and second parameters of the sine wave based on statistical measures of the process parameter determined from the measured data.

11. (Original) The method of claim 10, wherein the first parameter of the sine wave is an offset and the second parameter of the sine wave is a gain.

12. (Original) The method of claim 10, wherein determining the first and second parameters of the sine wave includes determining the offset as a mean value of the process parameter and determining the gain based on the difference between a minimum value and a maximum value of the process parameter.

13. (Original) The method of claim 10, including using a variable transformation of a mathematical expression of the sine wave that produces a linear expression having third and fourth sine wave parameters associated therewith, producing a set of transformed data points based on the variable transformation, performing a linear regression to fit the transformed data points to the linear expression and determining the third and fourth sine wave parameters based on the linear regression.

14. (Original) The method of claim 13, wherein the variable transformation is of the form:

$$z = \frac{\sin^{-1}(y) - a}{b}$$

wherein:

z is a transformed data point;

y is a measured data point;

a is a sine wave offset parameter; and

b is a sine wave gain parameter,

and wherein the linear expression is of the form:

$$z(t) = \omega t + \varphi$$

wherein:

z(t) is the transformed data point at a time t;

ω is a sine wave periodic frequency parameter; and

φ is a sine wave phase parameter.

15. (Original) The method of claim 14, further including applying a variable transformation to produce a further linear expression including the sine wave offset and gain parameters, applying a linear regression to the further linear expression to determine a new set of values for the sine wave offset and gain parameters and determining a new set of values for the sine wave periodic frequency and phase parameters based on the new set of values for the sine wave off set and gain parameters.

16. (Original) The method of claim 15, including iteratively determining values for the sine wave offset, gain, periodic frequency and phase parameters until a change in the values for one or more of the sine wave offset, gain, periodic frequency and gain parameters becomes less than a threshold value.

17. (Original) The method of claim 1, wherein determining the one or more statistical measures associated with the process parameter includes determining a baseline value of a first statistical measure of the process parameter and determining a further statistical measure of the process parameter from the measured data, and wherein using the one or more statistical measures associated with the process parameter to detect an abnormal situation within the process plant includes comparing the baseline value of the first statistical measure of the process parameter to the further statistical measure of the process parameter to determine the existence of an abnormal situation.

18. (Original) The method of claim 17, wherein determining the baseline value of the first statistical measure of the process parameter includes determining the baseline value as a statistical measure of a first set of the measured data, and wherein determining a further statistical measure of the process parameter from the measured data includes determining the further statistical measure of the process parameter from a second set of the measured data.

19. (Original) The method of claim 17, wherein determining the baseline value of the first statistical measure of the process parameter includes using a predetermined value of the process parameter as the baseline value of the first statistical measure of the process parameter.

20. (Original) The method of claim 17, wherein the process parameter is a differential pressure between two locations in the process plant.

21. (Original) The method of claim 20, wherein the differential pressure is a differential pressure between two trays of a distillation column.

22. (Original) The method of claim 21, wherein the differential pressure is a differential pressure between two adjacent trays of a distillation column.

23. (Original) The method of claim 21, wherein the differential pressure is a differential pressure between two non-adjacent trays of a distillation column.

24. (Original) The method of claim 21, wherein the baseline value of the first statistical measure of the process parameter is a low differential pressure value and wherein comparing the baseline value of the first statistical measure of the process parameter to the further statistical measure of the process parameter to determine the existence of an abnormal situation includes detecting tray dumping or tray damage when the further statistical measure of the process parameter is less than the low differential pressure value.

25. (Original) The method of claim 21, wherein the baseline value of the first statistical measure of the process parameter is a high differential pressure value and wherein comparing the baseline value of the first statistical measure of the process parameter to the further statistical measure of the process parameter to determine the existence of an abnormal situation includes detecting tray plugging when the further statistical measure is greater than the high differential pressure value.

26. (Original) The method of claim 20, wherein the process parameter is a differential pressure across a catalyst valve in a fluid catalytic cracker and wherein comparing the baseline value of the first statistical measure of the process parameter to the further statistical measure of the process parameter to determine the existence of an abnormal situation includes detecting an air blower problem when the mean value of the differential pressure across the catalyst valve is less than the baseline value.

27. (Original) The method of claim 20, wherein the process parameter is a differential pressure across a catalyst valve in a fluid catalytic cracker, and wherein comparing the baseline value of the first statistical measure of the process parameter to the further statistical measure of the process parameter to determine the existence of an abnormal situation includes detecting a catalyst flow problem when the standard deviation of the differential pressure across the catalyst valve is greater than the baseline value.

28. (Original) The method of claim 20, wherein the process parameter is a differential pressure between a catalyst regenerator and a reactor in a fluid catalytic cracker and wherein comparing the baseline value of the first statistical measure of the process parameter to the further statistical measure of the process parameter to determine the existence of an abnormal situation includes detecting an air flow malfunction when the differential pressure between the catalyst regenerator and the reactor in the fluid catalytic cracker is less than the baseline value.

29. (Original) The method of claim 17, wherein the process parameter is a level parameter.

30. (Original) The method of claim 29, wherein comparing the baseline value of the first statistical measure of the process parameter to the further statistical measure of the process parameter to determine the existence of an abnormal situation includes detecting pipe plugging when the further statistical measure of the level parameter becomes greater than the baseline value.

31. (Original) The method of claim 17, wherein the process parameter includes first and second level parameters and first and second pressure parameters and wherein the further statistical measure of the process parameter is a cross correlation between the first and second level parameters and the first and second pressure parameters and wherein comparing the baseline value of the first statistical measure of the process parameter to the further statistical measure of the process parameter to determine the existence of an abnormal situation includes

detecting plugging when the cross correlation between the first and second level parameters and the first and second pressure parameters exceeds the baseline value.

32. (Original) The method of claim 17, wherein the process parameter is a temperature parameter.

33. (Original) The method of claim 32, wherein the temperature parameter is a temperature in a reactor of a fluid catalytic cracker and wherein comparing the baseline value of the first statistical measure of the process parameter to the further statistical measure of the process parameter to determine the existence of an abnormal situation includes detecting insufficient steam flow when the statistical measure of the temperature in the reactor becomes greater than the baseline value.

34. (Original) The method of claim 33, wherein the statistical measure of the temperature in the reactor is a mean value of the temperature in the reactor.

35. (Original) The method of claim 32, wherein the temperature parameter is a temperature in a reactor of a fluid catalytic cracker and wherein comparing the baseline value of the first statistical measure of the process parameter to the further statistical measure of the process parameter to determine the existence of an abnormal situation includes detecting thermal extremes when the statistical measure of the temperature in the reactor becomes greater than a first baseline value or less than a second baseline value.

36. (Original) The method of claim 17, wherein the process parameter is a differential temperature between two locations of the process plant.

37. (Original) The method of claim 36, wherein the process parameter is a differential temperature between two locations of a fluid catalytic cracker and wherein comparing the baseline value of the first statistical measure of the process parameter to the further statistical measure of the process parameter to determine the existence of an abnormal situation includes detecting thermal cracking when the further statistical measure of the differential temperature exceeds the threshold.

38. (Original) The method of claim 37, wherein the process parameter is a differential temperature between a reactor and an exhaust pipe of the reactor within the fluid catalytic cracker.

39. (Presently Amended) A method of detecting an abnormal situation in a fluid catalytic cracker, comprising:

receiving measurements of a differential pressure ~~between two locations~~ across a catalyst valve in the fluid catalytic cracker;

using a processor for determining a ~~statistical measure~~ mean value of the differential pressure ~~between the two locations~~ across the catalyst valve in the catalytic cracker from the received ~~process parameter~~differential pressure measurements;

using a processor comparing the ~~statistical measure of the process parameter~~ mean value of the differential pressure across the catalyst valve to a baseline value; and

using a processor for detecting the existence of an ~~abnormal situation~~ air blower problem based on the comparison of the ~~statistical measure of the process parameter~~ mean value of the differential pressure across the catalyst valve to the baseline value when the mean value of the differential pressure across the catalyst valve is less than the baseline value.

40. (Original) The method of claim 39, further including determining the baseline value as a predetermined value.

41. (Original) The method of claim 39, further including determining the baseline value as a statistical measure of a first set of the measurements of the differential pressure.

42. Canceled

43. Canceled

44. Canceled

45-46. Canceled

47. Canceled

48. Canceled

49-50. Canceled

51. (Presently Amended) A method of detecting tray dumping or tray damage in a distillation column, the method comprising:

receiving measurements of a differential pressure between two locations in the distillation column;

using a processor for determining a mean value of the differential pressure from the differential pressure measurements;

using a processor for comparing the mean value of the differential pressure to a low differential pressure baseline value; and

using a processor for detecting the existence of tray dumping or tray damage based on the comparison of the mean value of the differential pressure to the low differential pressure baseline value when the mean value of the differential pressure is lower than the low differential pressure baseline value.

52. The method of claim 51, wherein the differential pressure is a differential pressure between two trays of the distillation column.

53. The method of claim 52, wherein the differential pressure is a differential pressure between two adjacent trays of the distillation column.

54-56. Canceled

57-69. Withdrawn

70. (Presently Amended) A method of detecting an abnormal situation in a fluid catalytic cracker, comprising:

receiving measurements of a level parameter in the fluid catalytic cracker;

using a processor for determining a mean value of the level parameter from the received level parameter measurements;

using a processor for comparing the statistical measure of the level parameter to a baseline value; and

using a processor detecting the existence of an abnormal pipe plugging situation based on the comparison of the statistical measure of the level parameter to the baseline value when the mean value of the level parameter becomes greater than the baseline value.

71. (Presently Amended) A method of detecting an abnormal situation in a fluid catalytic cracker, comprising:

receiving process measurements of a first level parameter and a first pressure parameter in a reactor of the fluid catalytic cracker and a second level parameter and a second pressure parameter in a regenerator of the fluid catalytic cracker;

using a processor for determining a cross correlation between the first and second level parameters and the first and second pressure parameters from the process parameter measurements;

using a processor for comparing the cross correlation between the first and second level parameters and the first and second pressure parameters to a baseline value; and

detecting an abnormal situation in the form of pipe plugging between the reactor and the regenerator when the cross correlation changes by a value greater than a baseline value.

72. (Presently Amended) A method of detecting an abnormal situation in a fluid catalytic cracker, comprising:

receiving measurements of a temperature parameter in the fluid catalytic cracker;

using a processor for determining a mean value of the temperature parameter from the temperature parameter measurements;

using a processor for comparing the mean value of the temperature parameter to a baseline value; and

using a processor for detecting ~~the existence of an abnormal situation~~insufficient steam flow based on the comparison of the mean value of the temperature parameter to the baseline

value when the mean value of the temperature in the fluid catalytic cracker becomes greater than the baseline value.

73. (Presently Amended) A method of detecting an abnormal situation in a fluid catalytic cracker, comprising:

receiving measurements of a differential temperature in the fluid catalytic cracker;

using a processor for determining a mean value of the differential temperature parameter from the differential temperature parameter measurements;

using a processor for comparing the mean value of the differential temperature parameter to a baseline value; and

using a processor for detecting the existence of an abnormal situation in the form of thermal cracking based on the comparison of the mean value of the temperature parameter to the baseline value when the mean value of the differential temperature parameter exceeds the baseline value.

74. (Presently Amended) A method of detecting tray plugging in a distillation column, comprising:

receiving measurements of a differential pressure parameter between two locations in the distillation column;

using a processor for determining a mean value of the differential pressure parameter from the differential parameter measurements;

using a processor for comparing the mean value of the differential pressure parameter to a high differential pressure baseline value; and

using a processor for detecting the existence of tray plugging based on the comparison of the mean value of the differential pressure parameter to the high differential pressure baseline value when the mean value of the differential pressure is higher than the high differential pressure baseline value.

75. (Previously Presented) The method of claim 74, wherein the differential pressure is a differential pressure between two trays of the distillation column.

76. (Previously Presented) The method of claim 74, wherein the differential pressure is a differential pressure between two adjacent trays of the distillation column.

77. (New Claim) A method of detecting an abnormal situation in a fluid catalytic cracker, comprising:

receiving measurements of a differential pressure across a catalyst valve in the fluid catalytic cracker;

using a processor for determining a standard deviation of the differential pressure across the catalyst valve in the catalytic cracker from the received differential pressure measurements;

using a processor comparing the standard deviation of the differential pressure across the catalyst valve to a baseline value; and

using a processor for detecting the existence of catalyst flow problem based on the comparison of the standard deviation of the differential pressure across the catalyst valve to the baseline value when the standard deviation of the differential pressure across the catalyst valve is greater than the baseline value.

78. (New Claim) The method of claim 77, further including determining the baseline value as a predetermined value.

79. (New Claim) The method of claim 77, further including determining the baseline value as a statistical measure of a first set of the measurements of the differential pressure.

80. (New Claim) A method of detecting an abnormal situation in a fluid catalytic cracker, comprising:

receiving measurements of a temperature parameter in the fluid catalytic cracker;

using a processor for determining a mean value of the temperature parameter from the temperature parameter measurements;

using a processor for comparing the mean value of the temperature parameter to a baseline value; and

using a processor for detecting thermal extremes based on the comparison of the mean value of the temperature parameter to the baseline value when the mean value of the temperature in the fluid catalytic cracker becomes greater than a first baseline value or less than a second baseline value.